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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Pamela A. Binns

Title: METHODS AND APPARATUS FOR SLACK STEALING WITH DYNAMIC THREADS

Docket No.: H16-25538

Serial No.: 09/751,955

Filed: December 29, 2000

Due Date: March 5, 2005

Examiner: Nilesh R Shah

Group Art Unit: 2127

MS Appeal Brief

Commissioner for Patents

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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:)
)
 Pamela A. Binns) Examiner: Niles R. Shah
)
 Serial No.: 09/751,955) Group Art Unit: 2127
)
 Filed: December 29, 2000) Docket: H16-25538.1-1611
)
 For: METHODS AND APPARATUS FOR SLACK STEALING WITH
 DYNAMIC THREADS)

APPEAL BRIEF UNDER 37 C.F.R. § 41.37

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Sir:

The Appeal Brief is presented in support of the Notice of Appeal to the Board of Patent Appeals and Interferences, filed on January 5, 2005, from the Final Rejection of claims 1-38 of the above-identified application, as set forth in the Final Office Action mailed on September 8, 2004.

The Commissioner of Patents and Trademarks is hereby authorized to charge Deposit Account No. 19-0743 in the amount of \$500.00 which represents the requisite fee set forth in 37 C.F.R. § 41.2(b)(2). The Appellants respectfully request consideration and reversal of the Examiner's rejections of pending claims.

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1. REAL PARTY IN INTEREST

The real party in interest of the above-captioned patent application is the assignee,
HONEYWELL INC..

2. RELATED APPEALS AND INTERFERENCES

There are no other appeals or interferences known to Appellant that will have a bearing on the Board's decision in the present appeal.

3. STATUS OF THE CLAIMS

Claims 1-38 are pending in the application and all are the subject of the present appeal.

4. STATUS OF AMENDMENTS

No claims were amended after the final rejection. Appendices were moved to start before the claims, and the amendment was entered in the advisory action mailed December 2, 2004.

5. SUMMARY OF THE INVENTION

A multitasking system executes real-time harmonic and dynamic tasks that can activate or deactivate (105; page 8, lines 21-27), at any time. Tasks are scheduled by assigning priority levels to tasks (103; page 8, lines 9-14), and determining available slack for tasks (105) at each priority level, taking into account tasks that are activating and inactivating (103).

Independent claim 1 describes a multitasking system (FIG. 2) executing real-time harmonic and dynamic tasks (14, 15, 16; page 8, lines 15-20) that can request activation or deactivation at any time. Scheduling tasks is done by assigning priority levels to tasks (103) and determining available slack for tasks at each priority level (105), taking into account tasks that are activating and inactivating (105). The slack is then allocated to tasks in order of priority (115). Claim 5 refers to determining timeline slack by maintaining a table (page 85, lines 16-20) that is recalculated at task activation and deactivation (107).

All independent claims reference taking into account tasks that are activating and deactivating.

Independent claim 21 describes a multitasking system with a process to execute a plurality of periodic and aperiodic tasks wherein each task of the plurality of tasks has associated with it at least one worst-case execution time. An executive controls dispatching of tasks on the processor. The executive determines available slack, taking into account aperiodic tasks that are requesting activation and deactivation at unpredictable times (page 80, lines 17-25; page 85, lines 16-20). It then allocates available slack to aperiodic tasks. In dependent claim 25, accumulators (109; page 85, lines 21-24) are used to store values representing slack consumed, reclaimed slack, and idle time, respectively. In claim 27, accumulators are predecremented to allow for overhead (113; page 86, lines 5-7). Reference number and page numbers are identified as examples of where the above elements are described in the application. The elements may be described further in further sections of the application.

6. ISSUES PRESENTED FOR REVIEW

Claims 1-38 were rejected under 35 USC § 103(a) as being unpatentable over Atlas et al. ('Slack Stealing Job Admission Control') in view of Anderson et al. (U.S. Patent No. 5,448,735).

8. ARGUMENT

1) The Applicable Law

The Examiner has the burden under 35 U.S.C. 103 to establish a *prima facie* case of obviousness. *In re Fine*, 837 F.2d 1071, 1074, 5 USPQ2d 1596, 1598 (Fed. Cir. 1988). As part of establishing a *prima facie* case of obviousness, the Examiner must show that some objective teaching in the prior art or some knowledge generally available to one of ordinary skill in the art would lead an individual to combine the relevant teaching of the references. *Id.*

The court in *Fine* stated that:

Obviousness is tested by "what the combined teaching of the references would have suggested to those of ordinary skill in the art." *In re Keller*, 642 F.2d 413, 425, 208 USPQ 871, 878 (CCPA 1981)). But it "cannot be established by combining the teachings of the prior art to produce the claimed invention, absent some teaching or suggestion supporting the combination." *ACS Hosp. Sys.*, 732 F.2d at 1577, 221 USPQ at 933. And "teachings of references can be combined *only* if there is some suggestion or incentive to do so."

Id. (emphasis in original).

The M.P.E.P. adopts this line of reasoning, stating that:

"In order for the Examiner to establish a *prima facie* case of obviousness, three base criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on Appellant's disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed.Cir. 1991))". *M.P.E.P.* 2142

The Office Action must provide specific, objective evidence of record for a finding of a suggestion or motivation to combine reference teachings and must explain

the reasoning by which the evidence is deemed to support such a finding. *In re Sang Su Lee*, 277 F.3d 1338, 61 USPQ2d 1430 (Fed. Cir. 2002).

The test for obviousness under § 103 must take into consideration the invention as a whole; that is, one must consider the particular problem solved by the combination of elements that define the invention. *Interconnect Planning Corp. v. Feil*, 774 F.2d 1132, 1143, 227 USPQ 543, 551 (Fed. Cir. 1985). The Examiner must, as one of the inquiries pertinent to any obviousness inquiry under 35 U.S.C. § 103, recognize and consider not only the similarities but also the critical differences between the claimed invention and the prior art. *In re Bond*, 910 F.2d 831, 834, 15 USPQ2d 1566, 1568 (Fed. Cir. 1990), *reh'g denied*, 1990 U.S. App. LEXIS 19971 (Fed. Cir. 1990). Finally, the Examiner must avoid hindsight. *Id.*

An invention can be obvious even though the suggestion to combine prior art teachings is not found in a specific reference. *In re Oetiker*, 24 USPQ2d 1443 (Fed. Cir. 1992). At the same time, however, although it is not necessary that the cited references or prior art specifically suggest making the combination, there must be some teaching somewhere which provides the suggestion or motivation to combine prior art teachings and applies that combination to solve the same or similar problem which the claimed invention addresses. One of ordinary skill in the art will be presumed to know of any such teaching. (See, e.g., *In re Nilssen*, 851 F.2d 1401, 1403, 7 USPQ2d 1500, 1502 (Fed. Cir. 1988) and *In re Wood*, 599 F.2d 1032, 1037, 202 USPQ 171, 174 (CCPA 1979)).

2) *Discussion of the Rejection of the Claims Under 35 U.S.C. § 103(a) as being unpatentable over Atlas et al. ('Slack Stealing Job Admission Control') in view of Anderson et al. (U.S. Patent No. 5,448,735).*

Claims 1-38

Claims 1-38 were rejected under 35 USC § 103(a) as being unpatentable over Atlas et al. ('Slack Stealing Job Admission Control') in view of Anderson et al. (U.S.

Patent No. 5,448,735). This rejection is respectfully traversed, as the references either alone or combined do not show each and every element of the claimed invention.

Atlas appears to be limited to only a static set of execution threads, i.e. a fixed set of recurring tasks without any new periodic tasks being activated and without any periodic tasks being deactivated. However, actual real-time processing environments typically contain a dynamic set of threads, as certain periodic tasks become active and others become inactive. This added complexity has not been taken into account in the slack stealing algorithm of Atlas et al.

The Examiner cites Anderson et al. as describing tasks that can activate and deactivate. However, Anderson et al. clearly does not deal with slack stealing. Anderson et al. groups tasks together to avoid unnecessary loading/saving of data in common storage areas. It teaches nothing of how such activation and deactivation of tasks can be accounted for in a slack stealing environment. It is not seen how these two references can be combined to result in the claimed invention.

The Final Rejection simply states that “It would have been obvious to one skilled in the art at the time of the invention to combine the teachings of Atlas and Anderson to ensure that a task can be activated or deactivated at anytime. By being able to activated or deactivated a task the user can determine and use excess slack thus making the entire system more efficient.” The rejection assumes the combination is possible, and then ascribes the motive of making the system more efficient to the combination. It is submitted that there is no teaching of how to add task activation and deactivation into the slack stealing algorithm, and thus, the likelihood of success has not been shown.

Anderson simply does not deal with slack stealing and does not indicate how the activation/deactivation feature could be added into slack stealing. Atlas also does not deal with activation and deactivation of tasks, likely because to do so would have been very difficult.

Applicant respectfully submits that the Office Action has not provided objective evidence for a suggestion or motivation to combine the references. There is no suggestion identified from the prior art, only an unsupported statement of objective intent, that at best is based on the actual combination made in the present application.

There must be some teaching somewhere which provides the suggestion or motivation to combine prior art teachings and applies that combination to solve the same or similar problem which the claimed invention addresses. The references are directed at solving very different problems. Atlas is directed to a slack-stealing job admission control system for scheduling periodic firm-deadline tasks with variable resource requirements as described in the Abstract. Anderson groups tasks together to avoid unnecessary loading/saving of data in common storage areas. These are very different aspects of computing that utilize very different techniques. Atlas is concerned with stealing slack time and allocating it to other tasks, while Anderson promotes efficient resource utilization by grouping tasks. There is no suggestion in either reference that the different techniques may be combined in a single system, and in fact, there is no assurance of success in attempting to make the combination since they solve very different problems.

If an independent claim is nonobvious under 35 U.S.C. §103, then any claim depending therefrom is nonobvious. MPEP §2143.03.

Claims 2-9, which depend from claim 1, directly or indirectly, and incorporate all of the limitations therein, are also asserted to be allowable for the reasons presented above.

Dependent claims 5 and 24 refer to determining timeline slack by maintaining a table that is recalculated at task activation and deactivation. The Examiner indicates that Atlas teaches maintaining a table that is recalculated. However, this table is not related to activation and deactivation, and therefore, cannot be recalculated based on task activation and deactivation as claimed.

Dependent claims 8, 27 and 34 reference predecrementing accumulators to allow for overhead associated with allocating slack. The Examiner indicates that this is shown in Atlas at page 2, lines 45-46 and page 4, lines 19, 23-24 and 36-37. No such teaching is found in Atlas. The citations to it provided by the Examiner appear to only refer to slack computed from the tasks that are being scheduled. No mention of overhead calculations was found. Since this element is lacking, the rejection should be reversed.

Independent claims 10, 11, 20, 21, and 29, along with their associated dependent

claims, were rejected based upon the same grounds as independent claim 1. Applicant respectfully asserts that these claims are all patentable over any suggested combination of Atlas and Anderson for the reasons present earlier regarding independent claim 1. Applicant respectfully requests that the rejection of claims 1-38 under 35 U.S.C. §103(a) as being unpatentable over Atlas in view of Anderson should be reversed.

Independent claim 21 is stated as rejected based on the same rejections as stated in claims 1, 4, 2, and 5-9 respectively. However, claim 21 further introduces the concept of periodic tasks requesting activation and deactivation at unpredictable times. Since this element has not been addressed, and is not apparent from the references, the rejection should be reversed.

Serial No.: 09/715,955

Filing Date: December 29, 2000

Title: METHODS AND APPARATUS FOR SLACK STEALING WITH DYNAMIC THREADS

9. SUMMARY

Applicant believes the claims are in condition for allowance and requests withdrawal of the rejections to claims 1-38. Reversal of the Examiner's rejections of claims 1-38 in this appeal is respectfully requested.

Respectfully submitted,

PAMELA A. BINNS

By his Representatives,

SCHWEGMAN, LUNDBERG,

WOESSNER & KLUTH, P.A.

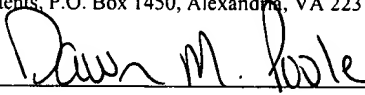
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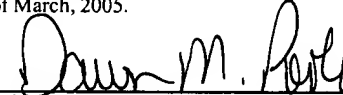
Date 3-7-2005 By 
Bradley A. Forrest
Reg. No. 30,837

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Name



Signature



APPENDIX I

The Claims on Appeal

1. (Original) In a multitasking system executing real-time harmonic and dynamic tasks that can request activation or deactivation at any time, a method of scheduling tasks comprising:
 - assigning priority levels to tasks;
 - determining available slack for tasks at each priority level, taking into account tasks that are activating and inactivating; and
 - allocating slack to tasks in order of priority.
2. (Original) The method of claim 1, wherein tasks are scheduled according to a rate monotonic algorithm.
3. (Original) The method of claim 1, wherein an aperiodic high priority task can steal slack from available slack without impacting an execution deadline of a periodic low priority task.
4. (Original) The method of claim 1, wherein determining available slack comprises:
 - determining slack consumed;
 - determining timeline slack;
 - determining reclaimed slack; and
 - determining idle time.
5. (Original) The method of claim 4, wherein determining timeline slack comprises maintaining a table that is recalculated at task activation and deactivation.
6. (Original) The method of claim 4, wherein determining available slack comprises maintaining accumulators for slack consumed, reclaimed slack, and idle time.

7. (Original) The method of claim 6, wherein tasks have periods, and wherein maintaining the accumulators comprises updating the accumulators upon the occurrence of an event from the group consisting of:
 - when crossing a period boundary;
 - when a task completes for period when executing on a fixed budget with slack to be reclaimed;
 - when a processor executing the tasks transitions from idle to busy;
 - when a task completes for period when executing on slack; and
 - prior to calculating available slack for a new slack-consuming task.
8. (Original) The method of claim 6, wherein determining available slack comprises predecrementing accumulators to allow for overhead associated with allocating slack.
9. (Original) The method of claim 1, wherein the multitasking system is a flight control system.
10. (Original) A machine-readable medium having instructions stored thereon capable of causing a processor to carry out a method, the method comprising:
 - assigning priority levels to tasks;
 - determining available slack for tasks at each priority level, taking into account tasks that are activating and inactivating; and
 - allocating slack to tasks in order of priority.
11. (Original) In a multitasking system executing real-time harmonic and dynamic tasks which can request activation or deactivation at any time, a method of scheduling tasks comprising:
 - determining available slack for tasks, taking into account tasks that are activating and inactivating; and
 - allocating slack to requesting tasks.

12. (Original) The method of claim 11, wherein tasks are scheduled according to a rate monotonic algorithm.

13. (Original) The method of claim 11, wherein each task has an assigned priority, and wherein an aperiodic high priority task can steal slack from available slack without impacting an execution deadline of a periodic low priority task.

14. (Original) The method of claim 11, wherein determining available slack comprises:

- determining slack consumed;
- determining timeline slack;
- determining reclaimed slack; and
- determining idle time.

15. (Original) The method of claim 14, wherein determining timeline slack comprises maintaining a table that is recalculated at task activation and deactivation.

16. (Original) The method of claim 14, wherein determining available slack comprises maintaining accumulators for slack consumed, reclaimed slack, and idle time.

17. (Original) The method of claim 16, wherein tasks have periods, and wherein maintaining the accumulators comprises updating the accumulators upon the occurrence of an event from the group consisting of:

- when crossing a period boundary;
- when a task completes for period when executing on a fixed budget with slack to be reclaimed;
- when a processor executing the tasks transitions from idle to busy;
- when a task completes for period when executing on slack; and
- prior to calculating available slack for a new slack-consuming task.

18. (Original) The method of claim 16, wherein determining available slack comprises predecrementing accumulators to allow for overhead associated with allocating slack.

19. (Original) The method of claim 11, wherein the multitasking system is a flight control system.

20. (Original) A machine-readable medium having instructions stored thereon capable of causing a processor to carry out a method, the method comprising:
determining available slack for tasks, taking into account tasks that are activating and inactivating, by:

determining slack consumed;
determining timeline slack;
determining slack reclaimed; and
determining idle time;
and

allocating slack to requesting tasks.

21. (Previously Presented) A multitasking system, comprising:
a processor to execute a plurality of tasks, wherein each task of the plurality of tasks is of a task type selected from the group consisting of periodic and aperiodic, and wherein each task of the plurality of tasks has associated with it at least one worst-case execution time; and
an executive to be in communication with the processor and to control dispatching of tasks on the processor, wherein the executive comprises:
a first module that is to determine available slack, taking into account aperiodic tasks that are requesting activation and deactivation at unpredictable times; and
a second module that is to allocate available slack to aperiodic tasks.

22. (Previously Presented) The multitasking system of claim 21, wherein the first module is to determine available slack by determining slack consumed, timeline slack, reclaimed slack, and idle time.
23. (Previously Presented) The multitasking system of claim 21, wherein the executive is to control the dispatching of tasks according to a rate monotonic algorithm.
24. (Previously Presented) The multitasking system of claim 21, wherein the first module is to determine timeline slack by maintaining a table and recalculating same when aperiodic tasks are activated and deactivated.
25. (Original) The multitasking system of claim 21, and further comprising accumulators to store values representing slack consumed, reclaimed slack, and idle time, respectively.
26. (Previously Presented) The multitasking system of claim 25, wherein tasks have periods, and wherein the processor is to update accumulators upon the occurrence of an event from the group consisting of:
- when crossing a period boundary;
 - when a task completes for period when executing on a fixed budget with slack to be reclaimed;
 - when the processor transitions from idle to busy;
 - when a task completes for period when executing on slack; and
 - prior to calculating available slack for a new slack-consuming task.
27. (Previously Presented) The multitasking system of claim 25, wherein the first module is to predecrement accumulators to allow for overhead.
28. (Original) The multitasking system of claim 21, wherein the multitasking system is a flight control system.

29. (Original) In a multitasking system executing real-time processes that can request activation or deactivation at any time, a method of scheduling processes comprising:
- assigning priority levels to processes;
 - determining available slack for processes at each priority level, taking into account processes that are activating and inactivating; and
 - allocating slack to processes in order of priority.
30. (Original) The method of claim 29, wherein processes are scheduled according to a rate monotonic algorithm.
31. (Original) The method of claim 29, wherein an aperiodic high priority process can steal slack from available slack without impacting an execution deadline of a periodic low priority process.
32. (Original) The method of claim 29, wherein determining available slack comprises:
- determining slack consumed;
 - determining timeline slack;
 - determining reclaimed slack; and
 - determining idle time.
33. (Original) The method of claim 32, wherein determining timeline slack comprises maintaining a table that is recalculated at process activation and deactivation.
34. (Original) The method of claim 32, wherein determining available slack comprises maintaining accumulators for slack consumed, reclaimed slack, and idle time.

35. (Original) The method of claim 34, wherein processes have periods, and wherein maintaining the accumulators comprises updating the accumulators upon the occurrence of an event from the group consisting of:

when crossing a period boundary;

when a process completes for period when executing on a fixed budget with slack to be reclaimed;

when a processor executing the processes transitions from idle to busy;

when a process completes for period when executing on slack; and

prior to calculating available slack for a new slack-consuming process.

36. (Original) The method of claim 34, wherein determining available slack comprises predecrementing accumulators to allow for overhead associated with allocating slack.

37. (Original) The method of claim 1, wherein the multitasking system is a flight control system.

38. (Original) The method of claim 1, wherein the multitasking system is a real-time control system.